COSTS OF DELIVERING GROCERIES AND FROZEN FOODS TO RESTAURANTS IN COMBINED OR SEPARATE LOADS

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PREFACE

One out of every three meals is eaten away from home in the United States. This amounts to $40 billion or 29 percent of the $138 billion spent for food in 1973. In the next 10 years institutional feeding is expected to double and two out of three meals will be eaten away from home.

Faced with rising costs, the institutional wholesalers supplying food service operators are constantly seeking ways of increasing efficiency in their distribution operations. This study was conducted to assist these distributors to pinpoint delivery costs by determining the relative costs of shipping combined loads of groceries and frozen foods on dual-purpose delivery vehicles with the costs of using single-purpose vehicles and separate deliveries. Determination of these costs can guide the distributor in selecting delivery equipment and in adopting methods of operation that produce lower overall costs.

This study was designed by the author. The data were supplied under contract by James A. Mixon and Associates, Inc., Food Industry Services, Washington, D.C., and were evaluated by the author.

Special acknowledgment is due the following distributors who provided essential data and made their operations available for time studies: Baer Foods, Hagerstown, Md.; Capitol Foods, Atlanta, Ga.; Frederick Produce Company, Frederick, Md.; and Sandler Foods, Norfolk, Va.

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This study was conducted under the general supervision of Kenneth H. Brasfield, Chief, Food Distribution Research Laboratory, Agricultural Marketing Research Institute, Agricultural Research Service.

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Names of commercial organizations and equipment illustrated in this publication are solely to provide specific information and do not imply endorsement by the U.S. Department of Agriculture over other organizations or similar equipment not given.

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COSTS OF DELIVERING GROCERIES AND FROZEN FOODS TO RESTAURANTS IN COMBINED OR SEPARATE LOADS

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SUMMARY

In this study the costs are compared of delivering groceries and frozen foods in combined or separate loads to food service establishments from local warehouses. To simplify the comparisons, two types of delivery fleets were simulated from information supplied by four food service distributors. Costs for these fleets were based on delivering identical volumes—3,900 cases on peak days to 300 customers, with groceries and nonfrozen perishables comprising 70 percent of the cases and frozen foods 30 percent.

One of the two fleets consisted of 12 dual-purpose vehicles with 18-foot bodies equipped for hauling combined loads in separate compartments. The other fleet had 17 smaller single-purpose vehicles, 10 of which had 14-foot uninsulated bodies for hauling 2,712 cases of groceries and 7 had 10-foot insulated bodies for hauling 1,188 cases of frozen foods on peak days.

The two fleets were compared based on the costs of owning and operating the vehicles and on labor costs. Overall costs were higher for the single-purpose fleet of 17 smaller trucks, primarily because this fleet had to make 480 delivery stops as compared with only 300 for the dual-purpose fleet of 12 large vehicles. Thus 180 stops were duplicated for customers who ordered both groceries and frozen foods.

The fleet of 17 single-purpose vehicles traveled an additional 183,205 miles annually, consumed about 30,500 more gallons of gasoline, and used 7,600 more man-hours of labor. Costs for the single-purpose fleet of 17 vehicles were $50,432 higher annually than for the dual-purpose fleet of 12 vehicles.

Labor costs for the single-purpose fleet were $38,386 higher and truck operating costs were $18,188 higher than for the dual-purpose fleet. These costs were somewhat offset by higher ownership costs for equipment, refrigeration, and the costs of hauling the refrigeration equipment, which were $2,643, $2,409, and $1,090 lower, respectively, for the single-purpose fleet.

Based on annual sales of $6.5 million, the increased costs would amount to 0.78 percent of sales. At a gross margin of 17 percent, this increase would represent 4.5 percent of the total gross margin.

INTRODUCTION

In recent years many wholesalers specializing in supplying restaurants, cafeterias, and other public or private eating places have been adding other lines of merchandise to (1) gain more of the customer's business and (2) gain efficiency and lower costs associated with handling and delivering larger orders. Dry grocery wholesalers have been adding frozen foods, frozen food wholesalers have been adding dry groceries, and produce operators have been adding both groceries and frozen foods

to their product lines. In a 1974 survey, 83.0 percent of institutional distributors carried dry groceries and 74.7 percent frozen foods.[1]

Previous research by the U.S. Department of Agriculture demonstrated the effect of order size on delivery costs.[2] In the firms studied the delivery costs ranged from 12.9 percent of the selling price for orders of less than 5 cases to 1.5 percent for orders of 55 cases when delivered an average distance of 20 miles.

Previous studies also have shown that small orders can represent a major share of a distributor's total operating costs. Adding product lines and thus increasing order size can substantially reduce these costs. However, one paradox observed is that some firms adding frozen foods to grocery lines or vice versa ship frozen foods in refrigerated delivery vehicles and dry groceries and perishables in ordinary grocery vans. These firms are obviously not realizing the per unit cost reductions that could be achieved with combined deliveries.

A study was undertaken therefore to measure the cost benefits that might accrue from shipping groceries and frozen foods in combined rather than separate loads. To establish a practical base for the comparison, delivery operations were studied at four participating wholesale firms that handle both grocery and frozen products.

Data from the four participating distributors were used to simulate two delivery fleets with identical volumes, product mixes, and delivery routes so that comparisons could be made under identical circumstances. Based on adjusted averages of the data obtained from the four distributors, the following delivery characteristics were assumed:

(1) A delivery volume on normal peak days of 3,900 cases, of which about 70 percent or 2,712 cases were groceries, including nonfrozen perishables, and 30 percent or 1,188 cases were frozen foods.

(2) Delivery service on normal peak days to 300 customers for an average of 13 cases.

(3) A total of 208 delivery days per year at the assumed volume of 3,900 cases. This is an average of 4 peak days per week out of a normal 5½-day delivery week. Deliveries on slow and moderate days, normally Mondays, Tuesdays, and Saturdays, were combined to represent 1 peak day.

Costs were developed for 12 delivery trucks with 18-foot bodies used by the fleet hauling combined loads. The 12 vehicle truck bodies totaled 216 lineal feet. It was assumed that all were insulated, refrigerated, and equipped with movable bulkheads to separate the frozen foods from the groceries.

Costs were also developed for 17 delivery trucks used by the fleet hauling groceries and frozen foods in separate trucks. Seven of these trucks were assumed to have 10-foot bodies, which were insulated and refrigerated for hauling straight loads of frozen foods. The other 10 trucks were assumed to be straight grocery vans with 14-foot bodies. The 17 vehicle truck bodies totaled 210 lineal feet.

Costs for owning and operating vehicles included refrigeration equipment and the labor required to load, drive, unload trucks, and close down delivery trips. Costs for owning and operating vehicles were obtained from the four participating distributora and from equipment manufacturers.

Labor costs were determined by making time studies of various operations performed by personnel of the four participating distributors. Miles driven and time consumed on delivery routes were derived from records kept by these distributors for a 1-week period.

Company overhead and administrative costs were assumed to be equal for both fleets and therefore were not included in the comparisons.

OPERATING CHARACTERISTICS OF THE FIRMS STUDIED

The data collected from the four firms were used to establish a "universe" for the study with respect to load size, average order size, order mix, truck utilization, travel time, and distance covered on route.

Load Size

Delivery tickets for a 1-week period for each of the four distributors were analyzed. They repre-

[1] 9TH ANNUAL SURVEY OF THE INDUSTRY. Inst. Distrib. 2 (No.1): 48. Jan. 1975.

[2] KARITAS, J. J. DETERMINING COSTS OF SERVICING WHOLESALE INSTITUTIONAL GROCERY ORDERS U.S. Dept. Agr. Agr. Mktg. Res. Rpt. 752, 20 pp. 1966.

sented a total of 250 delivery trips and 4,200 orders. The trips were plotted by load size. About 66 percent of the truckloads were under 300 cases (fig. 1).

The major reason for the modest loads was that on Mondays and Saturdays the delivery loads were light and increased from moderate on Tuesdays to heavy on Fridays. Another factor accounting for small loads was the urgency of making many deliveries before lunch.

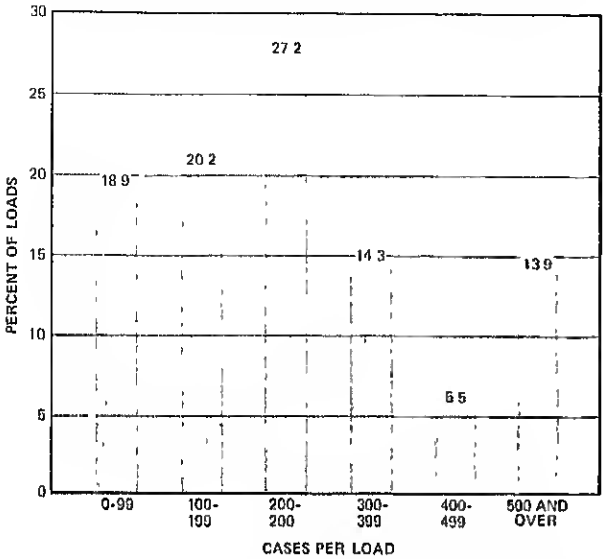

FIGURE 1.—Distribution of load sizes for 250 delivery trips representing 1 week's orders for 4 food service distributors.

Order Size

To obtain a stratification of order sizes, 4,200 individual orders were examined and classified by size (fig. 2). Almost half of the orders delivered in a week consisted of less than 10 cases. This relatively large percentage of small orders was due to restaurants requiring frequent deliveries and also to the spreading of business among several suppliers. The average order was about 13.5 cases.

Order Mix

Nearly 60 percent of the orders delivered from these firms were combined loads of groceries (including perishables) and frozen foods, 10.7 percent were frozen foods only, and 29.8 percent were groceries or perishables or both (fig. 3).

These distributors used insulated or uninsulated, straight refrigerated or compartmentalized, and refrigerated truck bodies for delivery. During the winter the perishables were shipped with the groceries and in warmer months with the frozen foods.

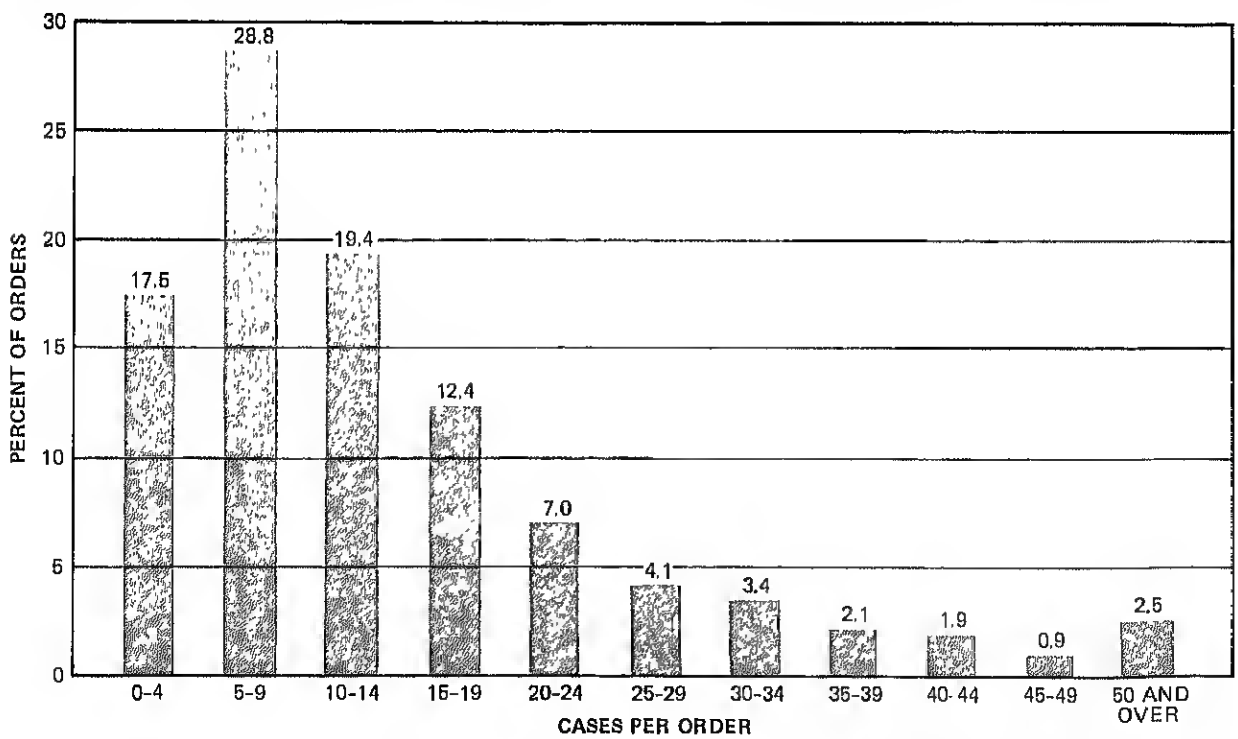

FIGURE 2.—Distribution of order sizes for 4,200 orders representing 1 week's deliveries for 4 food service distributors.

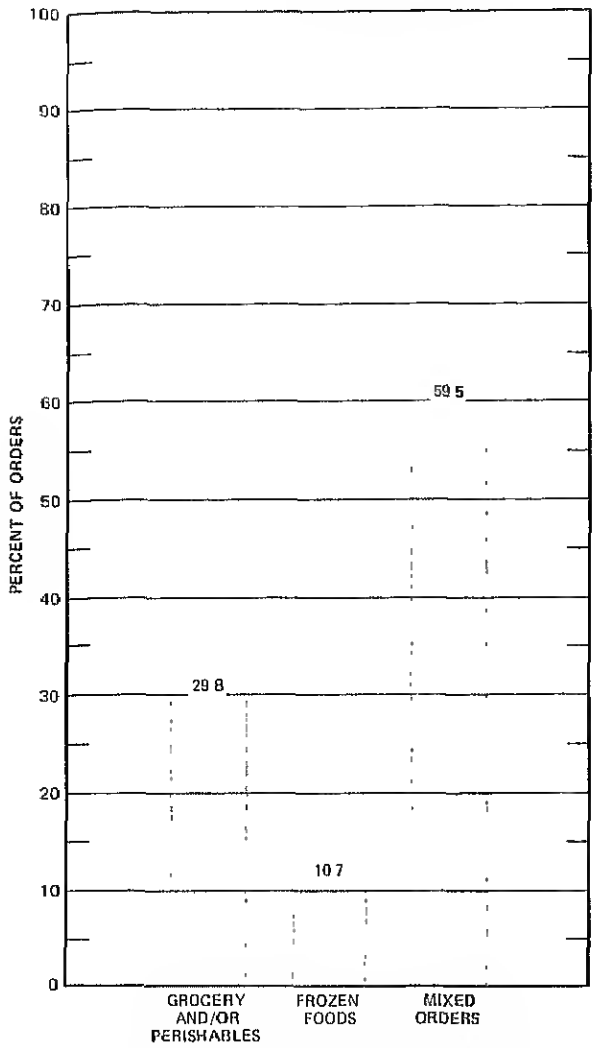

FIGURE 3.—Distribution of order mixes for 4,200 orders representing 1 week's deliveries for 4 food service distributors.

In single-compartment refrigerated trucks the perishables, frozen foods, and groceries were shipped together, and insulated blankets protected selected items from the low temperature. Another method was to ship frozen foods in containers with groceries on uninsulated truck bodies. Dry ice was added to the containers for refrigeration.

Order Size, Mix, and Load Composition

To develop the costs for combined and separate deliveries of groceries and frozen foods, it was necessary to determine the number of cases of each commodity on each truck of the two fleets as well as the number of orders to be delivered. For costing purposes, the average order size and approximate product mix in the firms studied were selected to create a "universe" as follows:

The average order was 13 cases. The ratio of groceries and frozen foods to the amount of cases shipped was 70 percent for groceries and 30 percent for frozen foods; also—

(1) Sixty percent of the cases were shipped as combined orders of groceries and frozen foods; a combined order contained nine cases of groceries and four cases of frozen foods,

(2) Twenty-eight percent of the cases were straight grocery orders shipped in combined loads,

(3) Twelve percent of the cases were straight frozen food orders shipped in combined loads.

The two simulated fleets each delivered 3,900 cases of combined or separate loads of groceries and frozen foods to the same 300 customers on a "peak day" of the week.

TABLE 1.—*Dual purpose fleet: Stops, order size and mix, and cases per truck and fleet to deliver groceries and frozen foods*[1]

Item	Stops per—		Order size and mix		Cases per truck	Cases per fleet		
	Truck	Fleet	Groceries	Frozen foods		Groceries	Frozen foods	Total
	Number	*Number*	*Cases*	*Cases*	*Number*	*Number*	*Number*	*Number*
1	15	180	9	4	195	1,620	720	2,340
2	7	84	13	...	91	1,092	...	1,092
3	3	36	..	13	39	..	468	468
Total	25	300	...	...	325	2,712	1,188	3,900

[1] Trucks Nos. 1-12 with 18-ft bodies.

To deliver 3,900 cases of combined orders with the order size and mix given and using the dual-purpose fleet, 300 stops were required (table 1).

To deliver the same 3,900 cases with the same order size and mix and using the single-purpose fleet, 264 stops were required for grocery trucks and 216 stops for the frozen food trucks, or a total of 480 stops. Since some customers received more than one daily delivery, the single-purpose fleet had 60 percent more stops, even though the same number of cases were delivered by both fleets (tables 1 and 2).

TABLE 2.—*Single-purpose fleet: Stops, order size, and cases per truck and fleet to deliver groceries and frozen foods*

Item	Groceries					Frozen foods				
	Stops per—		Order size	Cases per—		Stops per—		Order size	Cases per—	
	Truck	Fleet		Truck	Fleet	Truck	Fleet		Truck	Fleet
	Number	*Number*	*Cases*	*Number*	*Number*	*Number*	*Number*	*Cases*	*Number*	*Number*
	Trucks Nos 1-9[1]					Trucks Nos. 1-6[2]				
1	18	162	9	162	1,458	26	156	4	104	624
2	9	81	13	117	1,053	5	30	13	65	390
Total	27	243	..	279	2,511	31	186	..	169	1,014
	Truck No 10[1]					Truck No. 7[2]				
3	18	18	9	162	162	24	24	4	96	96
4	3	3	13	39	39	6	6	13	78	78
Total	21	21	.	201	201	30	30		174	174
Grand total	.	264	..	...	2,712		216		..	1,188

[1] 14-ft bodies.
[2] 10-ft bodies.

COSTS

Included here are a comparison of costs for combined and separate loads, the basis for the comparisons, and how the various costs were obtained and applied.

In the final comparison are given the annual equipment ownership and operations costs and the labor costs for 2 fleets each delivering 3,900 cases per peak day for 208 peak days, with one fleet delivering combined loads of groceries and frozen foods and the other delivering separate loads.

The costs for delivery equipment were based on sizes and capacities as recommended by distributors and equipment manufacturers and were based on late 1973 prices. An average of the mechanical equipment, holdover plate system, and liquid nitrogen system was used to determine the costs of refrigerating trucks.

Delivery Equipment

The type of delivery equipment used affects comparative delivery costs in (1) the initial cost, which is reflected in cost of ownership, and in (2) the cost of operating the equipment, as hauling the load. Initial costs are affected by the size of the body and the load weight, which also determine the size and capacity of the chassis cab; the way the body is constructed; the amount of insulation; the type of doors; and the size or capacity

and type of refrigeration equipment. Comparative operating costs are affected by the load weight, body, refrigeration equipment, and chassis cab.

Trucks used by the four participating distributors to haul separate loads of groceries or frozen foods were smaller than those used to haul combined loads in single- or dual-compartment vehicles. Truck bodies for hauling separate loads ranged from 10 to 14 feet in length, and those for combined loads ranged from 16 to 22 feet.

When combined loads of groceries and frozen foods are hauled on the same truck, the products can be either loaded into dual or separate compartments or mixed in a single compartment. Dual-compartment truck bodies have either fixed or movable bulkheads (partitions). If the bulkhead is fixed, only the front compartment has to be insulated and refrigerated. The construction of the rear compartment is similar to that of a grocery van. Truck bodies with movable bulkheads are insulated throughout.

A movable bulkhead can be positioned at any location in the truck body depending on the ratio of groceries to frozen foods for any one delivery. Dual-compartment vehicles, whether equipped with fixed or movable bulkheads, have two doors, one on the right side for access to the front compartment and one at the rear. The front compartment of a vehicle with a fixed bulkhead has to be loaded and unloaded from the side door, whereas a vehicle compartment with a movable bulkhead can be loaded from the rear by placing the bulkhead aside. One type of bulkhead can be stowed in a tiltup position on the ceiling or leaned against a sidewall of the truck body. Once the frozen foods have been loaded into the front compartment of the vehicle, the bulkhead is repositioned and secured. Groceries are then loaded in the rear compartment.

To unload a dual-compartment vehicle with either fixed or movable bulkheads, groceries and frozen foods are removed separately via the side and rear doors. However, movable and fixed bulkheads with hinged doors are available for rear-door unloading of frozen foods (fig. 4).

Single-compartment vehicles with only a rear door are used to haul either straight or combined loads of groceries or frozen foods. With straight oads, groceries are hauled on one fleet of trucks ıd frozen foods on another. With combined loads, the groceries and frozen foods in each order are loaded and stowed in the truck together and unloaded together.

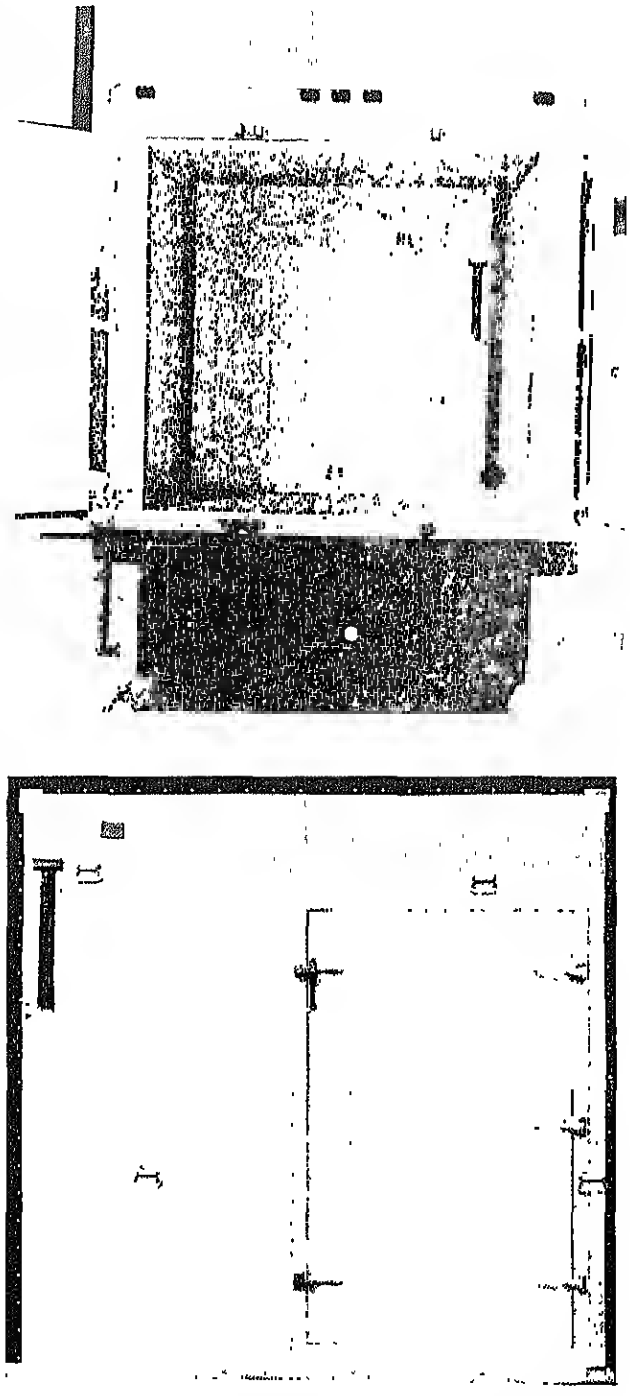

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FIGURE 4.—*Above*, truck body with movable bulkhead; *below*, movable bulkhead with hinged door.

Single-compartment trucks used for straight loads of frozen foods or combined loads of groceries and frozen foods are insulated throughout. When used for groceries, they have plain uninsulated bodies.

Refrigerated trucks and compartments are equipped with insulated doors. Although they are usually hinged, a new overhead foldback door is used by some distributors as a rear door in insulated trucks. It provides wide-open access into the truck when loading. Overhead rear doors are standard equipment on grocery vans and most dual-compartment vehicles. Because the overhead door folds back along the truck ceiling, partitions in dual-compartment vehicles have to be at least 7 feet from the rear of the truck.

The size of the compartment to be refrigerated determines the capacity of the refrigeration equipment required, provided the external heat loads and truck insulations are similar. A 10-foot body or compartment requires less refrigeration capacity than an 18-foot body. A dual-compartment vehicle with a movable bulkhead is normally refrigerated for 50 percent of the body length. Single compartments with combined loads of groceries and frozen foods are normally refrigerated for a straight frozen food load. Groceries or perishables requiring protection from low temperature during delivery are often covered with insulated blankets to prevent damage to the product.

A distributor can choose from three types of truck refrigeration systems (fig. 5): (1) A gasoline-driven system with the condenser outside the truck body and the evaporator fan coils inside. This system operates on a demand thermostat and can be used at any time. Larger units are equipped so that the entire unit will cycle on and off as the thermostat indicates. On smaller units the gasoline engine runs continuously, although the condenser cycles on and off as controlled by the thermostat.

(2) A eutectic holdover plate system with a condenser outside the truck body and eutectic plates inside. The electrically operated condenser recharges the plates only when plugged into a service outlet. The eutectic solution, which is well below 0° F, refrigerates the truck while it is on the road without the condenser operating.

(3) A liquid nitrogen system consisting of a tank either outside or inside the truck, controls outside the truck, and distribution headers inside the truck. This system normally is controlled by a thermostat, which causes some of the liquid nitrogen in the tank to be released inside the truck. The liquid nitrogen in the tank is about −360° F. When released into the air, it vaporizes and thus absorbs heat and reduces the air temperature in the truck. The nitrogen in the truck is recharged periodically from a central supply, usually at the distributor's warehouse.

Initial investment and operating costs of these systems vary from each other and from one distributor to another. Since this study was not intended to compare the costs of the three systems, an average was used to determine the cost of refrigeration for combined or separate loads. An average of the three systems also was used to compute the cost of hauling the refrigeration equipment.

A dual-compartment vehicle with a movable bulkhead was used in this study to represent combined loads, because thia equipment is the most common type ordered by distributors to haul combined loads. This is based on information supplied by several manufacturers of insulated trucks.

Delivery Equipment Requirements

The cost comparisons were based on the following three types of truck bodies plus suitable chassis and cab:

(1) An 18-foot fully insulated body with movable bulkhead and with refrigeration equipment sized to protect up to 50 percent of the contents or approximately 429 cubic feet of refrigerated space (9 by 7⅓ by 6½ ft).

(2) A 14-foot uninsulated body for groceries.

(3) A 10-foot inaulated body with refrigeration equipment sized to protect 100 percent of the contents.

Ownership and operation costs for refrigeration equipment were based on average costs of the following commonly used systems: (1) Mechanical refrigeration, (2) holdover plates, and (3) liquid nitrogen.

No attempt was made to judge the effectiveness of the three types of bodies or refrigeration equipment in protecting product quality.

A refrigerated vehicle with an 18-foot body and movable bulkhead was selected for shipping combined loads because it could accommodate 325

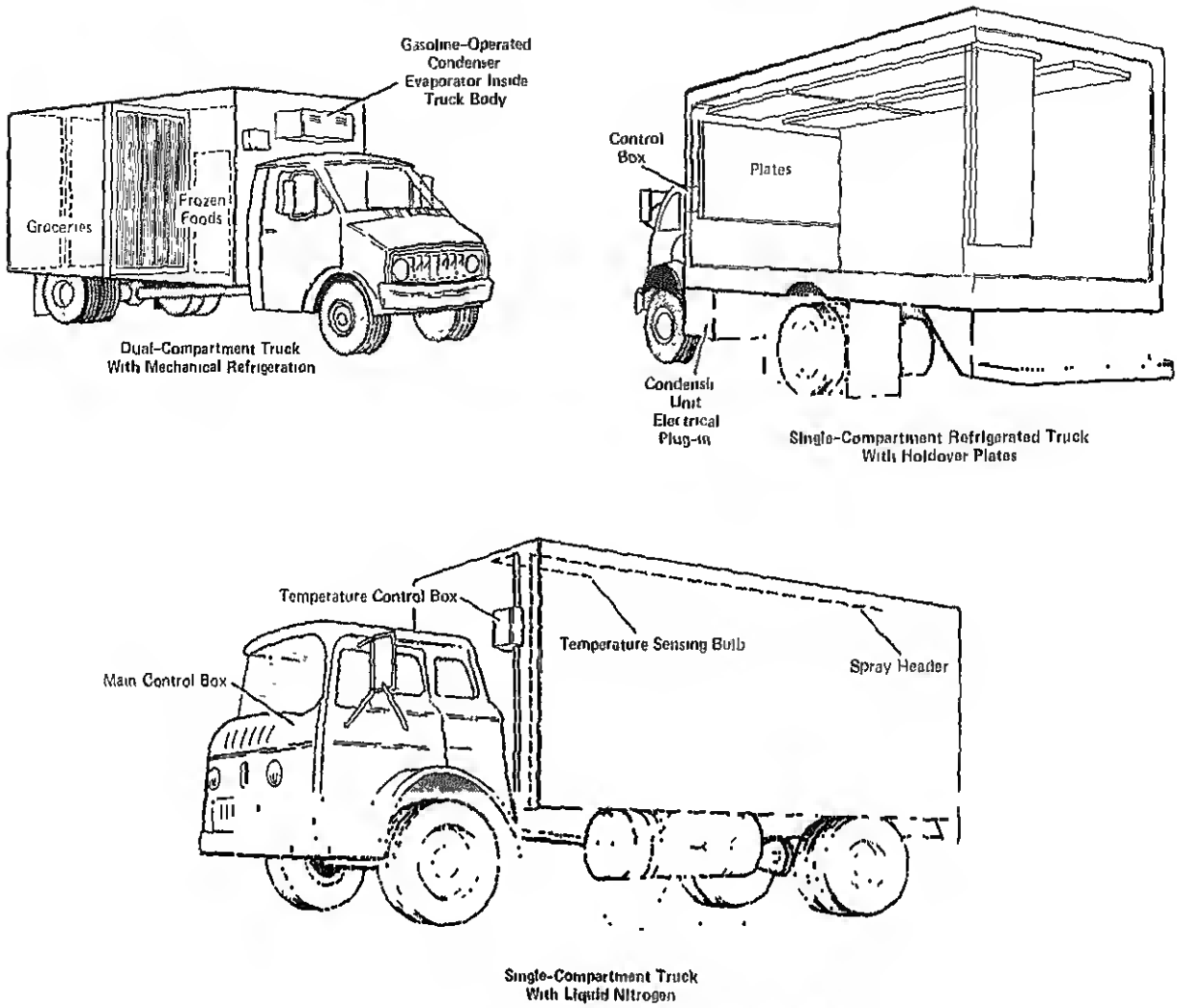

FIGURE 5.—Three types of commonly used refrigeration systems.

cases, a reasonable peak-day load. Twelve such vehicles were required to ship 3,900 cases on normal peak days. Their truck bodies were 216 lineal feet.

A 10-foot frozen food vehicle and a 14-foot dry grocery vehicle were selected for separate loads because these sizes were required to deliver the prescribed volumes and product mix for a maximum time on route of 9–10 hours per peak day. Shipping 3,900 cases of product in separate loads on normal peak days required a fleet of 7 vehicles for frozen foods and 10 for groceries. The combined truck bodies were 210 lineal feet.

Although a fleet of vehicles containing 216 or 210 lineal feet of truck body can haul over 3,900 cases, full capacities are usually unattainable in actual practice when numerous stops are made. For convenience of unloading, clearances are often left at doors, and when hauling frozen foods, space is left at the top of the load for air circulation. Also, when trucks are loaded with various sizes and shapes of cases, space is more difficult to fully utilize than when cases are of uniform size. Furthermore, distributors often purchase truck bodies slightly longer than needed at the time to permit expansion of load sizes.

Delivery Equipment Costs

To compare equipment costs for the two fleets, ownership and operating costs were developed for both the delivery and the refrigeration equipment.

Ownership Costs

Ownership costs for refrigeration equipment were based on an average of three types of equipment commonly used for refrigerated transport—mechanical refrigeration, holdover plates, and liquid nitrogen. Other kinds of refrigeration equipment were excluded from the study to limit the number of variables, and no attempt was made to determine the adequacy of the equipment. The equipment was sized and operating costs were determined by the contractor.

Ownership costs consisted of depreciation, interest on invested capital, insurance, and licenses.

Depreciation.—The chassis and cab of the delivery vehicle were depreciated over 4 years, truck body 6 years, and refrigeration equipment 5 years. The straight-line method of depreciation was used with no residual value. The initial purchase price also included an average cost for preparing refrigerated bodies for installation of the refrigeration equipment.

Interest on Invested Capital.—Interest costs were computed at an annual rate of 10 percent for one-half life expectancy and prorated over the full life.

Insurance.—Insurance costs were based on new equipment with coverage for bodily injury, property damage, personal driving protection, and uninsured motorists. Coverage for damage to cargo was also included in the annual premium. Costs included a 20-percent fleet discount.

Licenses.—License fees were based on 1974 charges for Maryland and on chassis weights of 4,700 pounds for the straight frozen food vehicle with a 10-foot body, 5,500 pounds for the straight grocery vehicle with a 14-foot body, and 6,300 pounds for the combination load vehicle with the 18-foot body.

Annual ownership costs for delivery and refrigeration equipment were $2,643 higher for the dual-purpose fleet. The major component of this difference was depreciation, which was $3,567 higher, interest on invested capital $1,360, and licenses $370. Partially offsetting these higher costs were insurance costs, which were $2,654 lower for the dual-purpose fleet (table 3).

Operating Costs

Operating expense for the two fleets consisted of costs of operating the vehicle and the refrigeration equipment and of hauling the additional weight of refrigeration equipment, insulation, and bulkheads and doors.

Vehicle Operating Costs.—Annual gas, oil, and maintenance costs for the dual-purpose fleet were $39,183 and for the single-purpose fleet $57,371, a difference of $18,188 or 46.4 percent (table 4). The single-purpose fleet also traveled 183,205 more miles annually than the dual-purpose fleet. At approximately 6 miles per gallon, the single-purpose fleet used about 30,500 more gallons of gasoline than the dual-purpose fleet.

Costs of Operating Refrigeration Equipment.—Refrigeration operating costs for the two fleets represented an average of operating costs for three systems and included estimated gasoline consumption for the mechanical system, electrical consumption for the holdover plate system, and nitrogen costs for the liquid nitrogen system. Costs also included estimates for repair and maintenance of the systems. Operating costs for refrigerating the 18-foot vehicles with a movable bulk-

TABLE 3.—*Annual ownership costs for dual- and single-purpose fleets*[1]

Item	Dual-purpose fleet	Single-purpose fleet			Increase for dual-purpose fleet
	Twelve 18-ft bodies[2]	Ten 14-ft bodies	Seven 10-ft bodies[2]	Total	
Depreciation	$41,796	$19,630	$18,599	$38,229	$3,567
Interest on investment	10,080	4,310	4,410	8,720	1,360
Insurance	10,716	7,630	5,740	13,370	−2,654
Licenses	2,160	1,300	490	1,790	370
Total	84,752	32,870	29,239	62,109	2,643

[1] For source of data, see appendix tables 13, 16, and 18.
[2] Includes refrigeration equipment.

head in the dual-purpose fleet were based on refrigerating 30 percent or 6 lineal feet of truck body with a capacity of 3,042 Btu per hour, even though the equipment was sized to refrigerate 50 percent of the load if necessary. The average cost for the three systems with this capability was $675 per vehicle annually or $8,100 per fleet (app. table 22).

The refrigerated vehicles in the single-purpose fleet each required a system with a capability of 5,070 Btu per hour for a 10-lineal foot truck body. Operating costs were $813 per vehicle annually or $5,691 for the fleet (app. table 22).

Costs of Hauling Additional Weight.—The weight of refrigeration equipment, insulation, and bulkheads and doors was based on an average weight for the three systems.

Each of the 12 refrigerated vehicles in the dual-purpose fleet required 2,137 pounds of additional weight, an increase of 10.44 percent of vehicle operating costs and additional annual fleet costs of $4,091 (app. table 14).

Each of the 7 refrigerated vehicles in the single-purpose fleet. Overall the single-purpose fleet incurred $14,689 more operating costs than the erating costs and additional annual fleet costs of $3,001 (app. table 19).

Total Operating Costs.—The largest difference in the annual operating costs for the two fleets was for gas, oil, and maintenance, which 'was $18,188 more for the single-purpose fleet. However, refrigeration cost $2,409 less and hauling additional weight cost $1,090 less for the single-purpose fleet. Overall the single-purpose fleet incurred $14,689 more operating costs than the dual-purpose fleet (table 5).

TABLE 4.—*Annual vehicle operating costs for gas, oil, and maintenance for dual- and single-purpose fleets*

Item	Dual-purpose fleet	Single-purpose fleet			Increase for single-purpose fleet
		Ten 14-ft bodies	Seven 10-ft bodies	Total	
Distance per year[1] ....miles..	318,564	279,074	222,695	501,769	183,205
Cost per mile .. ..dollars..	0.123	0.117	0.111	...	..
Cost per year ....do.....	39,183	32,652	24,719	57,371	[2]18,188

[1] Daily miles × 208 days × number of trucks (see app. exhibits A, B, and C).
[2] 46.4 percent over dual-purpose fleet costs

TABLE 5.—*Annual operating costs for dual- and single-purpose fleets*

Item	Dual-purpose fleet	Single-purpose fleet			Increase for single-purpose fleet
		Ten 14-ft bodies	Seven 10-ft bodies	Total	
Gas, oil, and maintenance.....	$39,183	$32,652	$24,719	$57,371	$18,188
Refrigeration	8,100	---	5,691	5,691	−2,409
Hauling additional weight...	4,091	---	3,001	3,001	−1,090
Total.....	51,374	32,652	33,411	66,063	14,689

LABOR UTILIZATION

In this study the labor required to deliver orders included loading vehicles, driving, unloading at food service establishments, and closing down delivery on return to the warehouse. Loading vehicles is often considered a warehousing rather than a delivery activity. However, it was necessary

to include loading as a delivery activity because it was affected by the type of delivery equipment used.

In this study four-wheel platform trucks were used to load vehicles. The orders were checked while on the platform trucks, and the cases were labeled with stop sequence numbers. These tasks were accomplished by one man calling and labeling the cases and another checking the invoices. Cases were stacked in the truck by one man pushing the platform truck into the vehicle and offloading it. As shown in figure 6, combined and separate loads were moved through the rear door of the vehicle. In loading combined products, frozen foods were moved first into the front compartment and then the groceries were placed in the rear after the movable bulkhead had been positioned and secured.

One man drove each truck, unloaded the orders, and transported them into the food service estab-

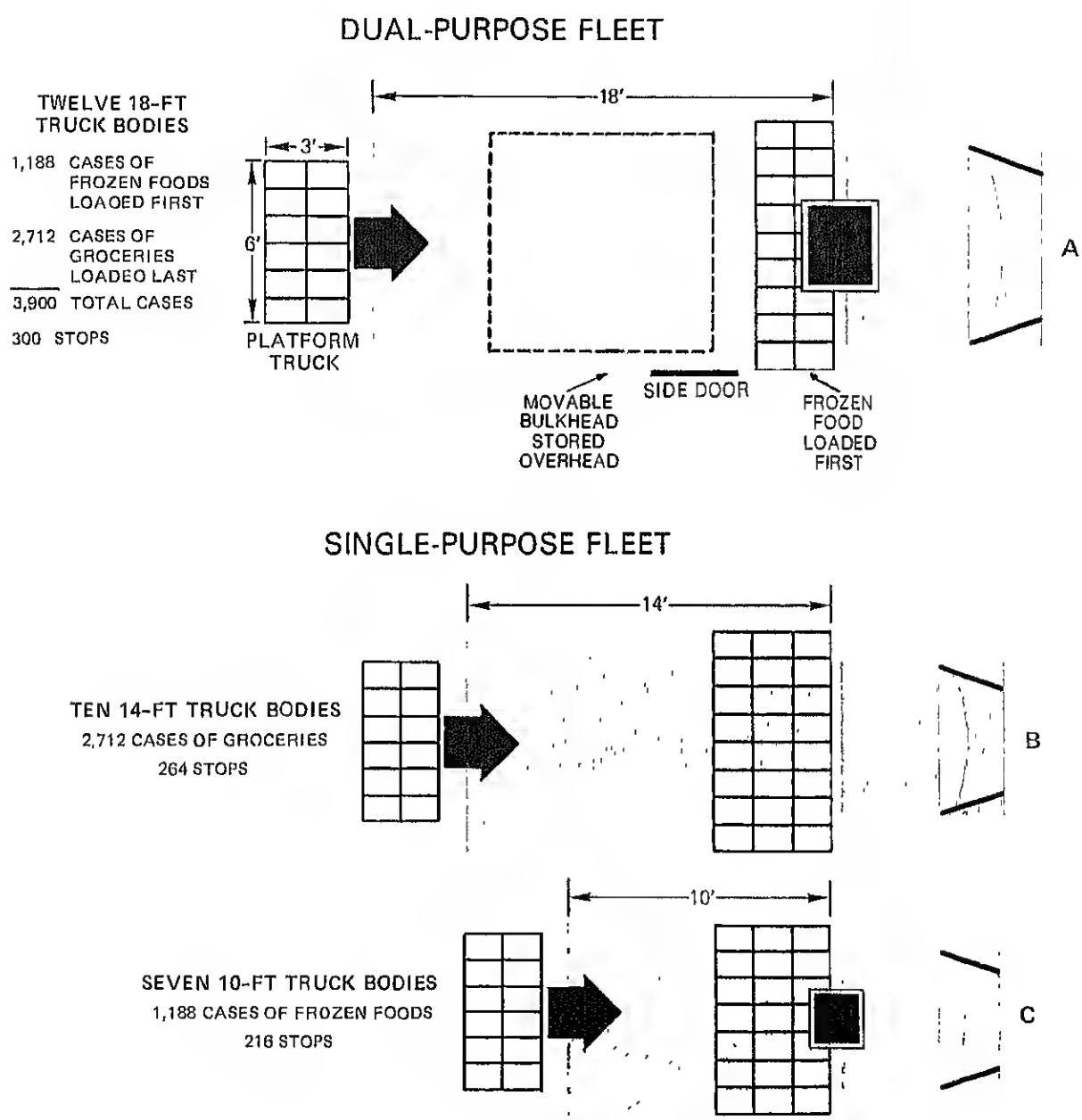

FIGURE 6.—Moving frozen foods and groceries into dual- and single-purpose fleets.

lishment using a two-wheel handtruck. When he returned to the warehouse, he removed the returned items and empty cases from the truck, parked the vehicle, and checked in his tickets and receipts at the office.

In hauling combined orders, it was necessary to unload from two doors—the groceries from the rear and frozen foods from the side. When hauling separate orders, all unloading was done from the rear.

LABOR COSTS

Labor costs were established for loading and unloading vehicles and for closing down delivery trips by conducting time studies on location or by using controlled laboratory procedures. Each task was broken into defined work elements.[3] Time values for these elements were established by using a stopwatch. These values were then adjusted to reflect the speed of an average operator working at a normal pace and applied at the frequency of occurrence to develop the production standard. An allowance of 15 percent was made for personal time and work fatigue.

Time studies of loading, unloading, closing down deliveries, and travel were adjusted to reflect the order sizes, mix, and stops required for the two fleets.

In addition, allowances were made for reasonable routine delays, such as waiting to have a delivery ticket receipted, as well as unavoidable nonroutine delays, such as unfastening a stuck door. Unreasonable delays, such as waiting an undue length of time for a c.o.d. collection, were not included as part of the standard times. Such delays often accounted for differences in actual man-hours utilized for a delivery trip and the standard times given. Actual times might also fluctuate over and below the established standard because of the varied work pace of employees, since a normal work pace was reflected in the standard times developed in this study.

An observer riding in the delivery vehicles recorded travel times and distances and conducted time studies of individual unloading operations. Delivery routes were classified as urban, suburban, or rural. Distances and travel times were established for travel from the warehouse to the first delivery stop, travel between delivery stops, and travel from the last delivery stop to the warehouse. These data were then applied to the dual-purpose and single-purpose fleets.

Total man-hours per trip on route, exclusive of unloading, averaged 5.19 for the dual-purpose fleet (app. table 21).

The distance traveled per trip for the dual-purpose fleet was 73.1 for urban, 121.4 for suburban, 188.4 for rural routes, and an average of 127.63 miles (app. table 21 and exhibit A).

For the single-purpose fleet, labor and mileage requirements were adjusted to reflect the number of stops required when delivering the number of orders previously discussed.[4]

Loading orders into vehicles was included as part of the labor costs for the two fleets; however, the loading usually was not performed by the driver of the vehicle. As previously mentioned, the two fleets were on route for approximately 9 to 10 driver hours per peak day per vehicle. A comparison of the daily loading time for the dual- and single-purpose fleets shows that the dual-purpose fleet required 1.17 man-hours longer (table 6). This difference was due to the extra time required to position and secure the bulkheads for combined loads and slightly greater travel distance required to move merchandise into an 18-foot body as compared with a 14- or 10-foot body.

The single-purpose fleet required 1.17 more unloading man-hours daily than the dual-purpose fleet (table 6). This difference was due to the larger number of trucks involved. The difference would have been even greater except for the additional time required to unload combined loads from both side and rear doors.

Labor differences for closing down delivery trips were minimal, with the single-purpose fleet requiring 0.53 more man-hour daily than the dual-purpose fleet.

The major difference between the fleets was travel time, with the single-purpose fleet requiring 36.38 more man-hours daily than the dual-purpose fleet. The principal reason for this difference was the time required for travel between the extra 180 stops by the single-purpose fleet.

In total, the single-purpose fleet incurred $184.55 more labor costs daily than the dual-purpose fleet, an increase of 26.9 percent (table 6). Annual labor

[3] r description of work elements, see appendix.

[4] See appendix exhibits B and C.

costs for the single-purpose fleet were $38,386.40 higher than for the dual-purpose fleet (table 7). As noted in the footnotes to table 6, adjustments to the time required for loading and unloading were made for the single-purpose fleet. They were required because grocery truck No. 10 of the single-purpose fleet delivered only 201 cases of groceries rather than 279 delivered by trucks Nos. 1–9, and frozen food truck No. 7 delivered 174 cases rather than 169 for trucks Nos. 1–6 (table 2).

TABLE 6.—*Daily labor requirements and costs for dual- and single-purpose fleets*[1]

Work element	Dual-purpose fleet	Single-purpose fleet		
	Twelve 18-ft bodies	Ten 14-ft bodies	Seven 10-ft bodies	Total
	Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
Load orders into vehicle	20.16	[2] 12 90	[3] 6.09	18.99
Unload orders from vehicle	52.92	[4] 33 30	[5] 20.79	54.09
Close down delivery	1.68	1.30	91	2.21
Travel on route	[6] 62 28	[7] 54.70	[8] 43.96	98.66
Total	137.04	102.20	71 75	173.95

Work element	Increase for single-purpose fleet		
	Labor	Cost[9]	Proportion[10]
	Man-hours	*Dollars*	*Percent*
Load orders into vehicle	−1.17	−5 85	−5.8
Unload orders from vehicle	1 17	5.85	2.2
Close down delivery	.53	2 65	31.6
Travel on route	36 38	181.90	58 4
Total or overall average	36.91	184.55	26 9

[1] See appendix for description of work elements and tables 12, 15, and 17 for source of data.
[2] Includes adjustment of 0.37 man-hour per fleet for loading (see app. exhibit B)
[3] Includes adjustment of 0.02 man-hour per fleet for loading (see app. exhibit C).
[4] Includes adjustment of 0.09 man-hour per truck for unloading (see app. exhibit B).
[5] Includes adjustment of 0.01 man-hour per truck for unloading (see app. exhibit C).
[6] See appendix exhibit A.
[7] See appendix exhibit B.
[8] See appendix exhibit C.
[9] Computed at $5 per hour.
[10] Increase-decrease in man-hours for single-purpose fleet ÷ man-hour requirements for dual-purpose fleet

TABLE 7.—*Annual labor costs for dual- and single-purpose fleets*

Work element	Dual-purpose fleet	Single-purpose fleet			Increase for single-purpose fleet
	Twelve 18-ft bodies	Ten 14-ft bodies	Seven 10-ft bodies	Total	
Load orders into vehicle	$20,966.40	$13,416.00	$6,333.60	$19,749.60	$−1,216.80
Unload orders from vehicle	55,036.80	34,632.00	21,621.60	56,253.60	1,216.80
Close down delivery	1,747.20	1,352.00	946.40	2,298.40	551.20
Travel on route	64,771.20	66,888.00	45,718.40	102,606.40	37,835.20
Total	142,521.60	106,288.00	74,620.00	180,908.00	38,386.40

TOTAL ANNUAL COSTS

When all costs for the two fleets are compared, the dual-purpose fleet with twelve 18-foot refrigerated bodies and movable bulkheads delivering combined loads of groceries and frozen foods had the lowest overall cost of $258,648 annually (table 8).

The single-purpose fleet with ten 14-foot dry grocery bodies and seven 10-foot refrigerated bodies shipping separate loads had annual costs of $309,080, or $50,432 more than the dual-purpose fleet, a difference of 19.5 percent.

The largest component of this difference was the higher cost of labor for the single-purpose fleet, amounting to $38,386. The major part of the labor cost difference (99 percent) was due to more travel time on route, requiring about 7,600 additional man-hours per year.

The next most important item was truck operations, costing $18,188 more for the single-purpose fleet. This difference was primarily due to increased gas consumption, about 30,500 gallons annually, for the additional 183,205 miles traveled.

Three other cost items—equipment ownership, refrigeration operations, and hauling extra weight—were lower for the single-purpose fleet by $2,643, $2,409, and $1,090, respectively.

A distributor shipping the quantities of groceries and frozen foods used in the comparison of the 2 fleets, 811,200 cases annually, would have sales of about $6.5 million at $8 per case. At this volume level the increased costs for the single-purpose fleet of $50,432 would amount to 0.78 percent of sales. If the distributor's gross margin was 17 percent, this increase would represent 4.5 percent of the total gross margin.

TABLE 8.—*Total annual costs for dual- and single-purpose fleets*[1]

Cost item	Dual-purpose fleet	Single-purpose fleet			Increase for single-purpose fleet	
	Twelve 18-ft bodies	Ten 14-ft bodies	Seven 10-ft bodies	Total		
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Percent*
Labor	142,522	106,288	74,620	180,908	38,386	26.9
Equipment ownership	64,752	32,870	29,239	62,109	−2,643	−4.1
Truck operations	39,183	32,652	24,719	57,371	18,188	46.4
Refrigeration operations	8,100	...	5,691	5,691	−2,409	−29.7
Hauling extra weight	4,091	...	3,001	3,001	−1,090	−26.6
Total or overall average	258,648	171,810	137,270	309,080	50,432	19.5

[1] Slight differences between data here and in other tables are due to rounding.

APPENDIX

Description of Work Elements in Delivering Orders to Food Service Establishments[1]

A. Load Orders Into Vehicle:

105 — *Make ready to load vehicle.*—Starts when checkers or loaders move from shipping with stack of tickets for a delivery run. Includes assembly of loading crew, setup or other makeready for loading, and assembling of shipping containers. Ends when preparations are completed and crew turns to check and/or load.

110 — *Check orders on platform truck.*—Starts when checker completes preparation and turns to begin check. Includes positioning of platform trucks and verifying and labeling cases with stop numbers. Ends when checking and labeling of one platform truck are completed and checker turns to other tasks.

111 — *Load orders from platform truck.*—Starts when loading crew completes preparation for loading and turns to load vehicle. Includes moving warehouse platform truck into vehicle and offloading merchandise, stacking merchandise in vehicle, and returning equipment to platform. Ende when all orders are etacked in vehicle and worker turns to other tasks.

121 — *Position and/or secure bulkhead.*—Starts when worker reaches for movable bulkhead in vehicle and ends when worker positions and fixes bulkhead up or down and turns to other tasks.

125 — *Make ready for vehicle departure.*—Starts when loading of vehicle is completed and crew turns to eecure load and vehicle. Includes placing handtruck in vehicle, closing truck doors, consolidating delivery tickets and manifest, and receiving instructions. Ends when driver enters cab of vehicle and turns to depart.

130 — *Unavoidable delay.*—See text.

B. Unload Orders From Vehicle:

315 — *Make ready to unload vehicle.*—Starts when driver completes parking of vehicle, scans order sheet, and turns to depart cab. Includes opening rear doors of vehicle, stepping or climbing into vehicle, moving handtruck to tailgate, and checking delivery tickets. Ends when driver completes preparation task and turns to begin unloading.

320 — *Move cases from stacks to rear door.*—Starts when driver completes preparation for unloading and reaches for cases of merchandise. Ends when driver moves all cases in an order from stack to door of vehicle and turns to other tasks.

324 — *Make ready to unload from side door.*—Starts when worker turns toward side door of vehicle. Includes dismounting from rear of truck and opening side door. Ends when worker climbs into vehicle and turns to unload.

325 — *Move cases from stack to side door.*—Starts when driver completes preparation for unloading and reaches for cases of merchandise. Ends when driver moves all cases in order from stack to door of vehicle, dismounts, and turns to other tasks.

326 — *Transport cases into establishment.*—Starts when driver reaches for handtruck. Includes loading merchandise onto handtruck, closing doors of vehicle when last case is removed, moving merchandise to establishment, opening doors of building, positioning load in establishment, returning to vehicle for additional loads, and cloeing and securing doors of vehicle when laet caee is removed. Ends when all cases are positioned and driver turns to other tasks. Time is expressed per order and is based on a one-way walking distance of 75 feet.

330 — *Check order and receipt.*—Starts when deliveryman reaches for delivery ticket to check order with customer's receiving clerk. Includes waiting, counting, and calling identification of merchandise. Ends when entire order is checked, clerk signs and removes copy of delivery ticket, and deliveryman turns to other tasks.

335 — *Stow merchandise.*—Starts when driver reaches for merchandise to place on shelves or on stacks in storage room(e). Includes etacking, rotating stock, rearranging, and poeitioning cases and ends when merchandise is stowed and deliveryman turns to other tasks.

[1] Elements under A, B, and C are used in tables 9-11 and those under D in table 21.

340 — *Collect c.o.d. orders.*—Starts when deliveryman moves to cashier to collect c.o.d. orders. Includes waiting for payment and ends when money or check is received and pocketed and deliveryman turns to depart.

345 — *Return to vehicle.*—Starts when driver completes delivery of merchandise and moves toward vehicle with handtruck. Includes opening and closing doors of establishment and ends when driver arrives at vehicle and turns to other tasks.

350 — *Make ready for departure.*—Starts when deliveryman moves to prepare vehicle for departure. Includes placing handtruck in vehicle, restacking merchandise, and closing vehicle doors. Ends when driver returns to truck cab, checks delivery tickets for next destination, and turns to start motor of vehicle.

C. Close Down Delivery:

410 — *Close down.*—Starts when driver turns off ignition key at warehouse platform and turns to dismount. Includes removing returns and empties from vehicle and stowing. Ends when worker completes putting vehicle in order, closes door, and turns to other tasks.

420 — *Park vehicle.*—Starts when driver moves to reboard vehicle cab. Includes starting motor and moving vehicle to parking area. Ends when driver turns off ignition, locks vehicle, and returns to warehouse.

425 — *Check in at warehouse.*—Starts when driver arrives at warehouse office to check in ticket, manifests, c.o.d.'s, etc. Ends when his check-in duties are completed, tickets, moneys, etc., are delivered to others, and driver turns to other tasks.

D. Travel on Route:

500 — *Travel from warehouse to first delivery stop.*—Starts when driver reaches for ignition switch to depart warehouse. Includes driving to first delivery stop and ends when driver parks vehicle and turns to unload.

503 — *Travel between each delivery stop.*—Starts when driver reaches for ignition switch to depart delivery stop. Includes driving to next delivery stop and ends when driver parks vehicle and turns to unload.

505 — *Travel from last delivery stop to warehouse.*—Starts when driver reaches for ignition switch to depart last delivery stop. Includes driving to warehouse and ends when driver parks vehicle and turns to dismount.

TABLE 9.—*Labor time required to load and deliver 25 orders of 325 cases consisting of 70-percent groceries and 30-percent frozen foods using a dual-compartment truck with movable bulkhead*[1]

Work element No and description (1)	Occurrences per trip (2)	Normal time per occurrence (3)	Men (4)	Standard time per occurrence[2] (5)	Standard time per trip[3] (6)	Elapsed time[4] (7)
	Number	*Man-minutes*	*Number*	*Man-minutes*	*Man-minutes*	*Man-minutes*
A Load orders into vehicle:						
105—Make ready to load vehicle	1	3.07	1	3 53	3 53	3 53
110—Check orders on platform truck[5]	325	.11	2	13	42 25	[6]SI
111—Load orders from platform truck[5]	325	10	1	12	39 00	39 00
121—Position and secure bulkhead	2	90	1	1 04	2 08	2 08
125—Make ready for vehicle departure	1	4.32	1	4 97	4 97	4 97
130—Unavoidable delay—10 percent	-	-	-		9 18	4 96
Total	-	-		-	101 01 min 1 68 h	54 54 mn 91 h
B Unload orders from vehicle						
315—Make ready to unload vehicle	25	73	1	84	21 00	21 00
320—Move cases from stacks to rear door	227	12	1	14	31 78	31 78
324—Make ready to unload from side door	18	55	1	63	11 34	11 34
325—Move cases from stack to side door	98	11	1	13	12 74	12 74
326—Transport cases into establishment	25	2 82	1	3 24	81 00	81 00
330—Check order and receipt	25	1 11	1	1 28	32 00	32 00
335—Stow merchandise	6	1 43	1	1 64	9 84	9 84
340—Collect c o.d. orders	5	1 27	1	1 46	7 30	7 30
345—Return to vehicle	25	41	1	47	11 75	11 75
350—Make ready for departure	25	40	1	46	11 50	11 50
130—Unavoidable delay—15 percent		...	-		34 54	34 54
Total	-	-			264 79 mn 4 41 h	264 79 mn 4 41 h
C. Close down delivery						
410—Close down	1	1.37	1	1 58	1 58	1 58
420—Park vehicle	1	1 70	1	1 96	1.96	1 96
425—Check in at warehouse	1	3 91	1	4 50	4 50	4 50
130—Unavoidable delay—5 percent	--	-			40	40
Total	-	--	--		8 44 mn 14 h	8 44 mn 14 h
Grand total (A, B, and C)	-	-	-		374 24 mn 6 24 h	327 77 mn 5 46 h

[1] Does not include travel on route.
[2] Includes 15-percent personal and fatigue factor; col 3 × 1 15 = col 5
[3] Based on col. 2 × col 5
[4] Based on col. 6 ÷ col 4
[5] Based on 70+ cases per platform truck.
[6] Since checking is performed simultaneously (SI) with other load elements, no additional elapsed time is charged for element 110

TABLE 10.—*Labor time required to load and deliver 27 orders of 279 cases of groceries using a single-compartment 14-ft truck body (9 orders of 13 cases each, 18 orders of 9 cases each)*[1]

Work element No. and description (1)	Occurrences per trip (2)	Normal time per occurrence (3)	Men (4)	Standard time per occurrence[2] (5)	Standard time per trip[3] (6)	Elapsed time[4] (7)
	Number	*Man-minutes*	*Number*	*Man-minutes*	*Man-minutes*	*Man-minutes*
A Load orders into vehicle						
105—Make ready to load	1	3 07	1	3 53	3 53	3 53
110—Check orders on platform truck[5]	279	11	2	13	36 27	[6]SI
111—Load orders from platform truck[5]	279	09	1	10	27 90	27 90
125—Make ready for vehicle departure	1	4 32	1	4 97	4 97	4 97
130—Unavoidable delay—10 percent	--	--	-	--	7 27	3 64
Total	-	-	-	-	79 94 min 1 33 h	40 04 min 67 h
B Unload orders from vehicle:						
315—Make ready to unload vehicle	27	73	1	84	22 68	22 68
320—Move cases from stacks to rear door	279	12	1	14	39 06	39 06
326a—Transport 9 cases into establishment	18	1 54	1	1 77	31 86	31 86
326b—Transport 13 cases into establishment	9	2 50	1	2 88	25 92	25 92
330—Check order and receipt	27	76	1	87	23 49	23 49
335a—Stow 9 cases of merchandise	6	93	1	1 07	6 42	6 42
335b—Stow 13 cases of merchandise	2	1.34	1	1.54	3 08	3 08
340—Collect c o.d. orders	6	1.27	1	1 46	8 76	8 76
345—Return to vehicle	27	41	1	47	12.69	12 69
350—Make ready for departure	27	40	1	.46	12 42	12 42
130—Unavoidable delay—15 percent	---	---	- -	- -	18 64	18 64
Total	-	--	---	---	205 02 min 3 42 h	205 02 min 3 42 h
C. Close down delivery						
410—Close down	1	1 05	1	1 21	1 21	1 21
420—Park vehicle	1	1 70	1	1 96	1.96	1.96
425—Check in at warehouse	1	3 91	1	4 50	4 50	4 50
130—Unavoidable delay—5 percent	---	- -	- -	- -	.38	38
Total	-	---	- -	--	8 05 min 13 h	8 05 min 13 h
Grand total (A, B, and C)	---	--		--	293 01 min 4 88 h	253 11 min 4 22 h

[1] Does not include travel on route.
[2] Includes 15-percent personal and fatigue factor; col. 3 × 1 15 = col 5
[3] Based on col. 2 × col. 5.
[4] Based on col 6 ÷ col. 4.
[5] Based on 70+ cases per platform truck.
[6] Since checking is performed simultaneously (SI) with other load elements, no additional elapsed time is charged for element 110.

TABLE 11.—*Labor time required to load and deliver 31 orders of 169 cases of frozen foods using a single-compartment 10-ft truck body (5 orders of 13 cases each, 26 orders of 4 cases each)*[1]

Work element No. and description (1)	Occurrences per trip (2)	Normal time per occurrence (3)	Men (4)	Standard time per occurrence[2] (5)	Standard time per trip[3] (6)	Elapsed time[4] (7)
	Number	*Man-minutes*	*Number*	*Man-minutes*	*Man-minutes*	*Man-minutes*
A. Load orders into vehicle:						
105—Make ready to load	1	3 07	1	3.53	3.53	3 53
110—Check orders on platform truck[5]	169	.11	2	13	21.97	[6]SI
111—Load orders from platform truck[5]	169	.09	1	10	16.90	16 90
125—Make ready for vehicle departure	1	4.32	1	4 97	4 97	4 97
130—Unavoidable delay—10 percent	---	---	---	-	4 74	2 54
Total	---	---	---	---	52.11 min .87 h	27 94 min 47 h
B. Unload orders from vehicle:						
315—Make ready to unload vehicle	31	73	1	84	26 04	26 04
320—Move cases from stacks to rear door	169	12	1	14	23 66	23.66
326a—Transport 4 cases into establishment	26	.77	1	.89	23 14	23.14
326b—Transport 13 cases into establishment	5	2 50	1	2 88	14 40	14 40
330—Check order and receipt	31	.65	1	72	22 32	22 32
335a—Stow 4 cases of merchandise	8	.41	1	47	3 76	3 76
335b—Stow 13 cases of merchandise	2	1 34	1	1 54	3 08	3 08
340—Collect c o-d orders	7	1.27	1	1 46	10 22	10 22
345—Return to vehicle	31	41	1	47	14.57	14 57
350—Make ready for departure	31	.40	1	46	14.26	14 26
130—Unavoidable delay—15 percent	---	---	---	--	23 32	23 32
Total	---	--	--	-	178 77 min 2 98 h	178 77 min 2 98 h
C. Close down delivery						
410—Close down	1	1.05	1	1 21	1 21	1 21
420—Park vehicle	1	1.70	1	1 96	1 96	1 96
425—Check in at warehouse	1	3 91	1	4 50	4 50	4 50
130—Unavoidable delay—5 percent	--	-	--	-	38	38
Total		--			8 05 min 13 h	8 05 min 13 h
Grand total (A, B, and C)	--		-		238 93 min 3 98 h	214 76 min 3 58 h

[1] Does not include travel on route.
[2] Includes 15-percent personal and fatigue factor, col. 3 × 1.15 = col 5
[3] Based on col 2 × col 5
[4] Based on col. 6 − col. 4
[5] Based on 70+ cases per platform truck.
[6] Since checking is performed simultaneously (SI) with other load elements, no additional elapsed time is charged for element 110

EXHIBIT A.—*Costs of labor and equipment required to load and deliver 3,900 cases of combined loads of 70-percent groceries and 30-percent frozen foods using twelve 18-ft truck bodies with movable bulkhead (dual-purpose fleet)*

1. Parameters:
   - A. Average truckload = 325 cases; average order size is 13 cases
   - B Load composition 60 percent of truckload is combined orders of groceries and frozen foods
     28 percent of truckload is straight grocery orders
     12 percent of truckload is straight frozen food orders

2. Requirements:
   - A. Number of stops required Mixed orders are 195 cases ÷ 13 cases = 15 stops
     Straight grocery orders are 91 cases ÷ 13 cases = 7 stops
     Straight frozen food orders are 39 cases ÷ 13 cases = 3 stops
   - B. Number of trucks required on peak days: One 18-ft truck body carrying 325 cases;
     3,900 cases per day ÷ 325 cases = 12 trucks or
     216 lineal ft of truck bodies
   - C. Man-hours required per trip:[1] Loading 1.68
     Unloading 4.41
     Close down delivery ..... .14
   - D. Man-hours required per trip[2] 5.19
   - E. Total man-hours required per trip 11.42
   - F. Miles required per trip[2] 127.63

3. Costs:
   - A. Labor cost ..... (11.42 h) × ($5 per hour)[3] $57.10
   - B. Equipment ownership cost per trip[4] 25.94
   - C. Equipment operating cost per trip:
     - (1) Delivery equipment ..... (127.63 mi) × ($0 123 per mile)[5] 15.70
     - (2) Refrigeration equipment ..... ($675 per year)[6] ÷ (208 peak days) 3.25
     - (3) Cost of hauling extra weight—refrigeration equipment[7] 1.64

     Total cost per trip 103.63

[1] From table 9.
[2] From table 21.
[3] Prevailing wage in areas where studies were conducted.
[4] From table 13
[5] Includes gas, oil, and maintenance (table 4).
[6] Average of 3 systems (from table 22).
[7] Annual cost (from table 14) ÷ 208 days and 12 trucks.

TABLE 12.—*Labor requirements and costs for dual-purpose fleet on peak days—twelve 18-ft bodies with movable bulkhead (combined loads)*

Work element	Daily time per—		Cost per fleet	
	Truck	Fleet[1]	Daily[2]	Annually[3]
	Man-hours	*Man-hours*	*Dollars*	*Dollars*
Load orders into vehicle	1.68	20.16	100.80	20,966.40
Unload orders from vehicle	4.41	52.92	264.60	55,036.80
Close down delivery	.14	1.68	8.40	1,747.20
Travel on route	5.19	62.28	311.40	64,771.20
Total	11.42	137.04	685.20	142,521.60

[1] × 12 trucks.

Item		Chassis and cab	Body	Refrigeration equipment	Total
Purchase price	dollars	7,000	6,854	[1]2,957	16,811
Depreciation period	years	4	6	5	--
Annual depreciation cost[2]	dollars	1,750	1,142	591	3,483
Interest on invested capital[3]	do	350	342	148	840
Insurance	do			-	893
Licenses	do		-	---	180
Total cost per					
Year[4]	do	2,100	1,484	739	5,396
Trip[5]	do			--	25.94

[1] Based on average investment costs for 3 systems capable of refrigerating 50 percent of the load.
[2] Straight line with no residual value.
[3] At 10 percent per year for ½ life of investment ÷ depreciation period.
[4] Based on data in 4 preceding entries
[5] Annual cost ÷ 208 peak days per year

TABLE 14.—*Increase in weight of truck and load and in annual fleet cost to haul extra refrigeration requirements for 18-ft insulated body with movable bulkhead (dual-purpose fleet)*

Item	Weight and cost
	Pounds
Truck and load (weight):	
Chassis	6,300
Uninsulated body	2,800
Load[1]	11,375
Total	20,475
Refrigeration requirements (weight):	
Insulation[2]	1,000
Doors and bulkhead	220
Equipment[3]	917
Total	2,137
	Percent
Proportion of loaded truck weight	10.44
	Dollars
Increased annual cost to haul refrigeration requirements[4]	4,091

[1] 325 cases × 35 lb.
[2] Based on insulating entire body.
[3] Average of 3 systems sized to refrigerate ½ of truck body or 9 ft (see app. table 20).
[4] Based on annual fleet operating cost (0.1044 × $39,183) (table 4).

EXHIBIT B.—*Costs of labor and equipment required to load and deliver 2,712 cases of dry groceries using ten 14-ft truck bodies (single-purpose fleet)*

1. Parameters:
   A. Average truckload = 279 cases
   B. Load composition (all groceries): 9 orders of 13 cases each = 117 cases
      18 orders of 9 cases each = 162 cases
      Total ..... 279 cases

2. Requirements:
   A. Number of stops required: 9 + 18 = 27 (subject to adjustment for fleet)[1]
   B. Number of trucks required on peak days: One 14-ft truck body carrying 279 cases × 10 trucks = 2,790 cases[1]
   C. Man-hours required per trip:[2] Loading[3] 1.29
      Unloading[4] 3 33
      Close down delivery ..... .13
   D. Man-hours required per trip[5] 5.47
   E. Total man-hours required per trip 10.22
   F. Miles required per trip[6] 134.17

3 Costs:
   A. Labor cost ..... (10.22 h) × ($5 per hour)[7] $51.10
   B. Equipment ownership cost per trip[8] 15.80
   C. Equipment operating cost per trip ..... (134.17 mi) × ($0.1170 per mile)[9] 15 70
      Total cost per trip 82.60

[1] Subject to adjustment since 279 cases × 10 trucks = 2,790 cases, an excess of 78 cases, or 6 orders of 13 cases per order.

[2] From table 10.

[3] Adjustment to load time for 78 less cases on truck No. 10: 78/279 = 27.96 percent of 1.33 man-hours = 0.37 man-hour; 1.33 man-hours × 10 trucks = 13.30 man-hours − 0.37 man-hour = 12.93 man-hours per fleet or 1.29 man-hours per truck.

[4] Time adjustment for fleet: Subtract standard time required to unload 6 orders of 13 cases or 78 cases. From table 10:
   (a) Item 315, 6/27, or 22.2 percent of 22.68 man-min = 5.03 man-min
   (b) Item 320, 78/279, or 28.0 percent of 39.06 man-min = 10.94 man-min
   (c) Item 326b, 6/9, or 66.7 percent of 25.92 man-min = 17.29 man-min
   (d) Item 330, 6/27, or 22.2 percent of 23.49 man-min = 5.21 man-min
   (e) Item 335b, 1/2, or 50 percent of 3.08 man-min = 1.54 man-min
   (f) Item 340, 1/6, or 16.7 percent of 8.76 man-min = 1.46 man-min
   (g) Item 345, 6/27, or 22.2 percent of 12.69 man-min = 2.82 man-min
   (h) Item 350, 6/27, or 22.2 percent of 12.42 man-min = 2.76 man-min
   (i) Total (a through h) = 47.05 man-min + unavoidable delay of 15 percent = 54.11 man-min
   (j) Adjustment for each of 10 trucks = 5.41 man-min, or 0.09 man-hour; 3.42 man-hours − 0.09 = 3.33 man-hours

[5] From table 21:

Minutes to first stop	26.28
Minutes between stops (11.19 min × 26)	290.94
Minutes from last stop to warehouse	16.56
Total minutes per trip	333.78

ess adjustment for 6 orders as in ftnt. 3; 6 orders = 5 between stops at 11.19 min = 55.95 min ÷ 10 trucks = 5.60 min per truck; 3.78 min − 5.60 min = 328.18 min or 5.47 h.

From table 21:

Miles to first stop	14.40
Miles between stops (4.31 mi × 26)	112.06
Miles from last stop to warehouse	9.87
Total miles per trip	136.33

djustment for fleet: Subtract the time between stops required for 6 stops; 4.31 mi × 5 = 21.55 mi ÷ 10 trucks = 2.16 mi
3 − 2.16 mi = 134.17 mi per truck.
age in areas where studies were conducted.

TABLE 15.—*Labor requirements and costs for single-purpose fleet on peak days—ten 14-ft bodies (groceries)*

Work element	Daily time per—		Cost per fleet	
	Truck	Fleet[1]	Daily[2]	Annually[3]
	Man-hours	*Man-hours*	*Dollars*	*Dollars*
Load orders into vehicle	1.29	12.90	64.50	13,416.00
Unload orders from vehicle	3.33	33.30	166 50	34,632 00
Close down delivery	.13	1.30	6.50	1,352.00
Travel on route	5.47	54.70	273 50	56,888.00
Total	10.22	102.20	511 00	106,288 00

[1] Man-hours per truck × 10 trucks; see exhibit B for source of data.
[2] At $5 per hour.
[3] Cost × 208 peak days.

TABLE 16.—*Equipment ownership costs per delivery vehicle with 14-ft body*

Item	Chassis and cab	Body	Total
Purchase price ..... dollars...	6,300	2,329	8,629
Depreciation period .. years ..	4	6	.
Annual depreciation cost[1] ..... dollars...	1,575	388	1,963
Interest on invested capital[2] ..... do	315	116	431
Insurance ..... do	...	...	763
Licenses ..... do	...	..	130
Total cost per—			
Year[3] ..... do	1,990	504	3,287
Trip[4] ..... do	...	...	15.80

[1] Straight line with no residual value.
[2] At 10 percent per year for ½ life of investment ÷ depreciation period.
[3] Based on data in 4 preceding entries.
[4] Annual cost ÷ 208 peak days per year.

EXHIBIT C.—*Costs of labor and equipment required to load and deliver 1,188 cases of frozen foods using 7 insulated 10-ft truck bodies (single-purpose fleet)*

1. Parameters:
   - A. Average truckload = 169 cases
   - B. Load composition (all frozen foods): 5 orders of 13 cases each = 65 cases; 26 orders of 4 cases each = 104 cases; Total ..... 169 cases

2. Requirements:
   - A. Number of stops required: 5 + 26 = 31
   - B. Number of trucks required on peak days: One 10-ft truck body carrying 169 cases × 7 trucks = 1,183 cases[1]
   - C. Man-hours required per trip[2]: Loading[3] ..... 0.87; Unloading[4] ..... 2 97; Close down delivery ..... .13
   - D. Man-hours required per trip[5] 6 28
   - E. Total man-hours required per trip 10 25
   - F. Miles required per trip[6] 152.95

3. Costs:
   - A. Labor cost ..... (10 25 h) × ($5 per hour)[7] $51 25
   - B. Equipment ownership cost per trip[8] 20 08
   - C. Equipment operating cost per trip:
     - (1) Delivery equipment ..... (152 95 mi) × ($0 111 per mile)[9] 16 98
     - (2) Refrigeration equipment ..... ($813 per year)[10] − (208 peak days) 3 91
     - (3) Cost of hauling extra weight—refrigeration equipment[11] 2 06
     - Total cost per trip 94.28

[1] 1 truck would have 5 additional cases or 174 cases per truckload and 1 additional stop.

[2] From table 11.

[3] Adjustment to load time for an additional 5 cases on truck No. 7:
5/169 = 3.0 percent of 0.87 man-hour = 0.02 man hour;
0.87 man-hour × 7 trucks = 6.09 man-hours + 0.02 = 6.11 man-hours;
6.11 ÷ 7 trucks = 0.873 man-hour.

[4] Time adjustment for fleet No. 1: Subtract standard time to deliver two 4-case orders; add standard time to deliver one 13-case order. From table 11:
- (a) Item 315, 1/31, or 3.2 percent of 26.04 man-min = 0.83 man-min
- (b) Item 320, 5/169, or 3.0 percent of 23.66 man-min = 0.71 man-min
- (c) Item 326a, 2/26, or 7.7 percent of 23.14 man-min = −1.78 man-min
- (d) Item 326b, 1/5, or 20.0 percent of 14.40 man-min = 2.88 man-min
- (e) Item 335a, 2/8, or 25.0 percent of 3.76 man-min = −0.94 man-min
- (f) Item 335b, 1/2, or 50.0 percent of 3.08 man-min = 1.54 man-min
- (g) Item 345, 1/31, or 3.2 percent of 14.57 man-min = 0.47 man-min
- (h) Item 350, 1/31, or 3.2 percent of 14.26 man-min = 0.46 man-min
- (i) Total (a through h) = 4.17 man-min + unavoidable delay of 15 percent = 4.80 man-min
- (j) Adjustment for each of 7 trucks = 4.80 min − 7 = 0.69 min or + 0.012 man-hour; 2.98 man-hours − 0.01 = 2.97 man-hours

[5] From table 21:

Minutes to first stop	26.28
Minutes between stops (11.19 min × 30)	335.70
Minutes from last stop to warehouse	16.56
Total minutes per trip	378.54

Adjustment to travel time: Subtract 1 stop at 11.19 min. or 1.6 min per truck; (378.54 min − 1.6 min = 376.94 min) or 6.28 h per truck (due to 1 less stop for truck No. 7).

[6] From table 21:

Miles to first stop	14.40
Miles between stops (4.31 mi × 30)	129.30
Miles from last stop to warehouse	9.87
Total miles per trip	153.57

Mileage adjustment for fleet: 1 between stop (4.31 mi) ÷ 7 trucks = 0.62 mi per truck; 153.57 − 0.62 mi = 152.95 mi per truck (due to 1 less stop for truck No. 7).

[7] Prevailing wage in areas where studies were conducted.

[8] From table 18.

[9] From table 4.

[10] Average of 3 systems (from table 22).

[11] Annual cost from table 19 ÷ 208 days and 7 trucks.

TABLE 17.—*Labor requirements and costs for single-purpose fleet on peak days—seven 10-ft bodies (frozen foods)*

Work element	Daily time per—		Cost per fleet	
	Truck	Fleet[1]	Daily[2]	Annually[3]
	Man-hours	*Man-hours*	*Dollars*	*Dollars*
Load orders into vehicle	0.87	6.09	30.45	6,333.60
Unload orders from vehicle	2.97	20.79	103.95	21,621.60
Close down delivery	.13	.91	4.55	946.40
Travel on route	6.28	43.96	219.80	45,718.40
Total	10.25	71.75	358.75	74,620.00

[1] Man-hours per truck × 7 trucks.

[2] At $5 per hour.

[3] Cost × 208 peak days.

TABLE 18.—*Equipment ownership costs per insulated refrigerated delivery vehicle with 10-ft body*

Item	Chassis and cab	Body	Refrigeration equipment	Total
Purchase price ..... dollars...	5,500	4,144	[1]2,957	12,601
Depreciation period... ..... years ...	4	6	5	...
Annual depreciation cost[2] ..... dollars ..	1,375	691	591	2,657
Interest on invested capital[3] ..... do	275	207	148	630
Insurance ..... do	..	...	...	820
Licenses ..... do . ..	...	...	...	70
Total cost per—				
Year[4] .. .. do	1,650	898	739	4,177
Trip[5] ..... do	.	...	...	20.08

[1] Based on average investment costs for 3 systems with capacity of 5,070 Btu per hour.
[2] Straight line with no residual value.
[3] At 10 percent per year for ½ life of investment ÷ depreciation period.
[4] Based on data in 4 preceding entries.
[5] Annual cost ÷ 208 peak days per year

TABLE 19.—*Increase in weight of truck and load and in annual fleet cost to haul extra refrigeration requirements for 10-ft insulated single-compartment body (single-purpose fleet)*

Item	Weight and cost
	Pounds
Truck and load (weight):	
Chassis	4,700
Uninsulated body	1,550
Load[1]	5,915
Total	12,165
Refrigeration requirements (weight):	
Insulation[2]	560
Equipment[3]	917
Total	1,477
	Percent
Proportion of loaded truck weight	12.14
	Dollars
Increased annual coat to haul refrigeration requirements[4]	3,001

[1] 169 cases × 35 lb.
[2] Based on insulating entire body.
[3] Average of 3 systems sized to refrigerate total truck body or 10 ft (see app. table 20).
[4] Based on annual fleet operating cost (0.1214 × $24,719) (table 4).

Length of truck body or compartment (feet)	Mechanical refrigeration system	Holdover system			Liquid nitrogen[2] system	Total	Average
		Condenser and other parts	Plates[1]	Total			
	Pounds	*Pounds*	*Number*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
4	700	280	3	920	1,200	650	2,550	850
5	700	280	3	920	1,200	650	2,550	850
6	700	280	3	920	1,200	650	2,550	850
7	700	280	4	920	1,200	650	2,550	850
8	700	280	4	1,120	1,400	650	2,750	917
9	700	280	4	1,120	1,400	650	2,750	917
10	700	280	4	1,120	1,400	650	2,750	917
12	700	280	4	1,120	1,400	650	2,750	917
14	1,000	280	4	1,120	1,400	650	3,050	1,017
16	1,000	320	5	1,360	1,680	650	3,330	1,110
18	1,100	360	6	1,470	1,830	650	3,580	1,193
20	1,100	360	6	1,580	1,940	650	3,690	1,230

[1] Weight of plates includes eutectic solution.
[2] Nitrogen tanks approximately ½ full.

TABLE 21.—*Average distance, time, and speed per trip for dual-purpose vehicle to deliver 325 cases to 25 customers in urban, suburban, and rural areas*[1]

Travel	Samples	Urban			Suburban			Rural			Average		
		Distance	Time	Speed	Distance	Time	Speed	Distance	Time	Speed	Distance	Time	Speed
	Number	*Miles*	*Man-minutes*	*Miles per hour*	*Miles*	*Man-minutes*	*Miles per hour*	*Miles*	*Man-minutes*	*Miles per hour*	*Miles*	*Man-minutes*	*Miles per hour*
(1) From warehouse to first delivery stop	71	5.26	16.92	18.7	11.77	24.05	29.3	26.18	37 88	41.5	14.40	26.28	29 8
(2) Between each delivery stop	1,150	2.55	11.42	13.4	4.17	10.83	23.1	6.20	11.32	32.4	4.31	11.19	23.0
(3) Between 25 delivery stops[2]	1,150	61.20	274.08	13.4	100.08	259.92	23.1	148.80	271.68	32 9	103 36	268.56	23.1
(4) From last delivery stop to warehouse	71	6.63	18.32	21.7	9.51	14.13	40.2	13.46	17.24	46 8	9.87	16.56	36.2
Totals:													
Out and back (1 + 4)	...	11.89	35.24	---	21.28	38.18	---	39 64	55.12	...	24.27	42.84	...
Out, delivery stops, and back (1 + 3 + 4).	...	73.09	309.32	---	121.36	298.10	---	188.44	326.80	...	[3]127.63	[4]311.40	...
Man-hours	—	—	5.16	---	---	4.97	---	---	5 45	...	...	5.19	...

[1] Includes allowances for meal and rest stops, but not unloading time.
[2] 24 × miles and man-minutes of previous entry.
[3] 127.63 ÷ 25 stops = 5.105 mi per stop.
[4] 311.40 ÷ 25 stops = 12.456 min per stop.

TABLE 22.—*Average estimated annual operating cost per vehicle for mechanical, holdover plate, and liquid nitrogen systems for refrigerated truck bodies or compartments*[1]

Length of truck body or compartment (feet)	Annual load	Average cost for 3 systems
	Btu	*Dollars*
4	2,028	626
5	2,535	650
6	3,042	675
7	3,549	701
8	4,056	756
9	4,563	784
10	5,070	813
12	6,084	857
14	7,098	886
16	8,112	955
18	9,126	976
20	10,140	1,013

[1] Based on operating 2,000 h per year.

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